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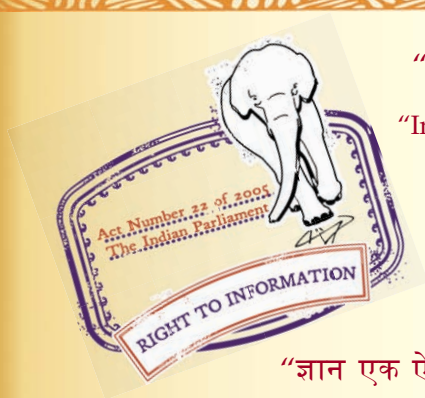
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“Step Out From the Old to the New”

IS 8880 (1978): Filter Units for Electromagnetic Interference Suppression [LITD 9: Electromagnetic Compatibility]



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“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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Indian Standard
SPECIFICATION FOR
FILTER UNITS FOR ELECTROMAGNETIC
INTERFERENCE SUPPRESSION

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Indian Standard

SPECIFICATION FOR FILTER UNITS FOR ELECTROMAGNETIC INTERFERENCE SUPPRESSION

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Indian Standard

SPECIFICATION FOR FILTER UNITS FOR ELECTROMAGNETIC INTERFERENCE SUPPRESSION

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 19 July 1978, after the draft finalized by the Electromagnetic Interference Suppression Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 The object of this standard is to specify safety and performance requirements, and tests for components and filter units for electromagnetic interference suppression for use in electrical circuits rated at up to 7 kVA.

0.3 This standard is not specifically intended to apply to circuits having ratings higher than 7 kVA, but many of its requirements may be of guidance in the construction of interference suppression for such circuits.

0.4 This standard is largely based on 'Draft British Standard specification for components and filter units for electromagnetic interference suppression' (revision of BS 613) issued by the British Standards Institution.

0.5 The limits for electromagnetic interference are covered by IS : 6842-1977*.

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard specifies safety and performance requirements, and tests for components and filter units for electromagnetic interference suppression for use in electrical machines, appliances and apparatus rated at up to 7 kVA, operating from 50 Hz mains supplies above extra low voltage and up to and including 240 V single phase or 415 V three-phase. Components rated for dc are also covered by this standard.

*Specification for limits for electromagnetic interference (*first revision*).

†Rules for rounding off numerical values (*revised*).

1.1.1 Suppression components or units for use in motor vehicles are not covered by this standard.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions, in addition to those covered in IS : 1885 (Part XXXVI)-1972*, shall apply.

2.1 Basic Insulation — Insulation applied to live parts to provide basic protection against electric shock.

NOTE — Basic insulation does not necessarily include insulation used exclusively for functional purposes.

2.2 Supplementary Insulation — Independent insulation applied in addition to basic insulation in order to provide protection against electric shock in the event of a failure of basic insulation.

2.3 Double Insulation — Insulation comprising both basic insulation and supplementary insulation.

2.4 Reinforced Insulation — A single insulation system applied to live parts, which provides a degree of protection against electric shock equivalent to double insulation under the conditions specified in the relevant standard.

NOTE — The term 'insulation system' does not imply that the insulation shall be one homogeneous piece. It may comprise several layers which may not be tested singly as supplementary or basic insulation.

2.5 Safety Impedance — An impedance connected between live parts and accessible conductive parts, of such value that the current, in normal use and under likely fault conditions in the equipment, is limited to a safe value, and which is so constructed that the reliability is maintained throughout the life of the equipment.

NOTE — Details of the likely fault conditions, the safe current and the requirements for reliability are as given in the relevant standards.

2.6 Safety Extra-Low Voltage (SELV) — A voltage which does not exceed 50 V ac rms (*see* Note 1) between conductors, or between any conductor and earth, in a circuit which is isolated from the supply mains by means such as a safety isolating transformer or converter with separate windings.

NOTE 1 — The dc value is under consideration.

NOTE 2 — Limitation to voltages lower than 50 V ac rms may be specified in the particular standard, especially when direct contact with live parts is involved.

NOTE 3 — The voltage limit should not be exceeded either at full load or no-load, but it is assumed, for the purpose of this definition, that any transformer or converter is operated at its rated supply voltage.

*Electrotechnical vocabulary: Part XXXVI Radio interference.

2.7 Permanently Earthed — An object is said to be permanently earthed when its electrical connection to an earthed electrode is rigidly and permanently secured throughout its whole length without the intervention of any circuit interrupting device and is protected from mechanical damage and corrosion, unless by its nature and construction such protection is unnecessary.

NOTE — Appliances earthed through the earth conductor of a flexible cable or cord terminating in a three-pole plug are not regarded as permanently earthed.

2.8 Live Part — A conductor which has a voltage relative to earth exceeding 34 V peak.

2.9 Filter Unit — An assembly, including a component or group of components in a housing, intended to be connected in electric circuits for the purpose of reducing unwanted currents and voltages.

2.10 Rated Voltage (U_R) — The maximum voltage of the supply to the apparatus in which the suppression component/filter unit is intended to be fitted.

2.11 Class 0 Equipment — Equipment in which protection against electric shock relies upon basic insulation; this implies that there are no means for the connection of accessible conductive parts, if any, to the protective conductor in the fixed wiring of the installation, reliance in the event of a failure of the basic insulation being placed upon the environment.

2.12 Class I Equipment — Equipment in which protection against electric shock does not rely on basic insulation only, but which includes an additional safety precaution in such a way that means are provided for the connection of accessible conductive parts to the protective (earthing) conductor in the fixed wiring of the installation in such a way that accessible conductive parts may not become live in the event of a failure of the basic insulation.

NOTE 1 — For equipment intended for use with a flexible cord or cable, this provision includes a protective conductor as part of the flexible cord or cable.

NOTE 2 — Where equipment designed as Class I is allowed to be fitted with a two-core flexible cord or cable provided that it is fitted with a plug which may not be introduced into a socket outlet with earthing contact, the protection is then equivalent to that of Class 0, but the earthing provisions of the equipment in all other respects should fully comply with the requirements of Class I.

2.13 Class II Equipment — Equipment in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions such as double insulation or reinforced insulation are provided, there being no provision for protective earthing or reliance upon installation conditions.

NOTE 1 — In certain special cases, such as the signal terminals of electronic equipment, safety impedance may be used in Class II equipment where it has been established that the safety impedance is necessary and that the technique may be included without detriment to the safety level.

NOTE 2 — Class II equipment may be provided with means for maintaining the continuity of protective circuits, provided that such means are within the equipment and are insulated from accessible surfaces according to the requirements of Class II.

NOTE 3 — In certain cases, it may be necessary to distinguish between 'all insulated' and 'metal-encased' Class II equipment.

NOTE 4 — Metal-encased Class II equipment may be provided with means for the connection of a potential equalization conductor to the enclosure only where such a need is recognized in the relevant standard.

NOTE 5 — Class II equipment may be provided with means for connection to earth for functional (as distinct from protective) purposes only where such a need is recognized in the relevant standard.

2.14 Class III Equipment — Equipment in which protection against electric shock relies on supply at safety extra-low voltage (SELV) and in which voltages higher than those of SELV are not generated.

NOTE 1 — Class III equipment should not be provided with means for protective earthing.

NOTE 2 — Metal-encased Class III equipment may be provided with means for the connection of a potential equalization conductor to the enclosure only where such a need is recognized in the relevant standard.

NOTE 3 — Class III equipment may be provided with means for connection to earth for functional (as distinct from protective) purposes only where such a need is recognized in the relevant standard.

2.15 Lower Category Temperature — The minimum ambient temperature for which a component/equipment has been designed to operate continuously.

2.16 Upper Category Temperature — The maximum ambient temperature for which a component/equipment has been designed to operate continuously.

3. CLIMATIC CATEGORIES

3.1 Suppression filter units covered by this standard shall belong to one of the following three categories based on their ability to withstand climatic severities.

<i>Climatic Test</i> (Ref to IS : 589-1961*)	<i>Severities</i>			
	Category 1		Category 2	Category 3
	A	B		
Dry heat	+125° C	+85° C	+85° C	+70° C
Cold	-55° C	-55° C	-40° C	-10° C
Damp heat (long term)	56 days	56 days	21 days	10 days
Damp heat (accelerated)	6 cycles	6 cycles	2 cycles	1 cycle
Rapid change of temperature	+125° C to -55° C	+85° C to -55° C	+85° C to -40° C	Not applicable
Low air pressure	4.4 kPa	4.4 kPa	8.5 kPa	600 kPa

*Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

4. GENERAL REQUIREMENTS

4.1 Suppression components and filter units shall be so designed and constructed that in normal use they function reliably and cause no damage or danger to persons or surroundings, even in the event of such careless use as may occur in normal service.

4.2 Individual specifications for particular equipment or appliances may contain additional requirements which the suppression components are required to meet. Certain specialised applications may require variations from this standard.

5. COMPONENT PARTS

5.1 Capacitors — The capacitors used for radio interference suppression shall conform to IS : 3723 (Part I)-1978* in addition to the following.

5.1.1 Maximum values of capacitance to be used for suppression in various circuit positions are, in general, limited by the leakage current allowed by the appropriate equipment specifications. Table 1 shows maximum nominal values (allowing for temperature coefficient and tolerances) for ac and ac/dc equipment which will generally not give excessive leakage current. Limiting values of capacitors for equipment operating on safety extra low voltage (SELV) supplies are not specified.

5.1.2 For equipment which has suppression capacitors connected to earth from points other than the line or neutral, any point which may have a voltage exceeding 30 V rms relative to earth, irrespective of the control setting, shall be considered to be the same as the line terminal for the purpose of determining the maximum values of these capacitors.

5.1.3 For equipment which may be utilized on either ac or dc supply circuits, the ac grade of capacitors shall be used.

5.1.4 Appropriate capacitors should be used for Class II equipment where the capacitors are connected between live parts and the inner insulated casing or frame, because of the high test voltages specified for such equipment.

5.1.5 Capacitors shall not be connected to exposed metal parts of Class II appliances.

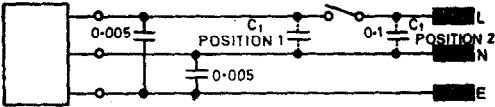
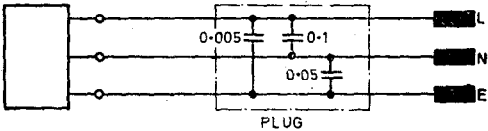
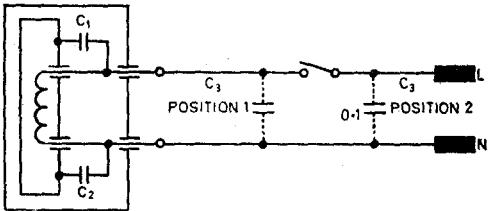
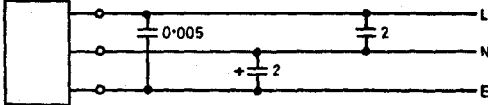
5.2 Inductors — The inductors used for radio interference shall conform to IS : 9229-1979†.

*Specification for capacitors for radio interference suppression: Part I-General requirements and methods of tests (*first revision*).

†Specification for inductors for radio interference suppression.

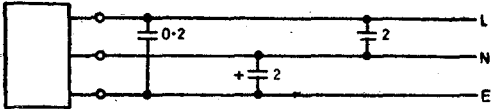
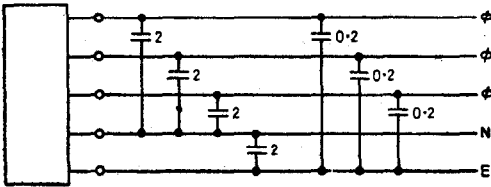
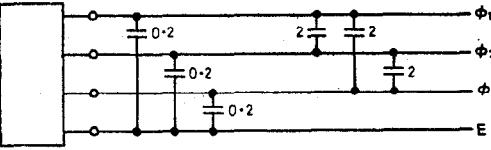
TABLE 1 MAXIMUM NOMINAL VALUES OF CAPACITANCE

(Clause 5.1.1)

TYPE OF SUPPLY	APPLICATION	MAXIMUM VALUES OF CAPACITANCE AND THEIR DISPOSITION. ALL IN μF
Single phase	In or on a Class I appliance connected to the supply mains by means of a plug and socket	 <p>C_1 in position 1 — No limit from safety aspect.</p>
Single phase	In the 3-pin plug for a Class I appliance	 <p>Plug</p>
Single phase	In or on a Class II appliance connected to the mains supply by means of a plug and socket	 <p>C_1, C_2 and C_3 in position 1 — No limit from safety aspect.</p>
Single phase	In or on a permanently earthed household apparatus	 <p>+ May need to be reduced if series earth leakage circuit breaker in use.</p>

(Continued)

TABLE 1 MAXIMUM NOMINAL VALUES OF CAPACITANCE—Contd

TYPE OF SUPPLY	APPLICATION	MAXIMUM VALUES OF CAPACITANCE AND THEIR DISPOSITION. ALL IN μF
Single phase	In or on a permanently earthed equipment excluding household apparatus	 <p>+ May need to be reduced if series earth leakage circuit breaker in use.</p>
3-phase 4 wire not exceeding 500 V between phases	In or on a permanently earthed apparatus	
3-phase 3 wire not exceeding 500 V between phases	In or on a permanently earthed apparatus	 <p>It is recommended that capacitors between phases and earth are the same nominal value, and that the supply circuit is protected by a circuit breaker which opens all circuits simultaneously.</p>

5.3 Resistors

5.3.1 All resistors used for radio interference suppression shall be capable of meeting the test requirements of the relevant detail specification.

5.3.2 Resistors shall be selected so as to conform to the temperature limits and high voltage and insulation tests as specified for the equipment with which they are used.

NOTE — Attention is drawn to the possible existence of transient voltage when a resistor is used in conjunction with a capacitor.

6. FILTER UNITS

6.1 Ratings — The preferred values of rated current shall be chosen from the following series:

R10 series of IS: 1076-1967* or its multiples or sub-multiples, for example, 1, 1.6, 2.5, 3.5, 4, 5, 6.3, 8 and 10.

6.2 Termination Markings

6.2.1 The filter unit terminations shall be identified by indelible marking in accordance with Table 2.

TABLE 2 IDENTIFICATION OF TERMINATIONS OF A FILTER UNIT

POINT OF CONNECTION (1)	IDENTIFICATION (2)
<i>A. Single phase</i>	
Live pole	L
Neutral pole	N
Earth	E or \equiv
<i>B. 3-phase</i>	
First phase	L1
Second phase	L2
Third phase	L3
Neutral	N
Earth	E or \equiv

6.2.1.1 Where the filter unit is embodied in a mains plug the terminal markings required by IS: 1293-1967† applicable to that plug shall be used.

6.2.1.2 Where the performance of the filter is affected by the method of connection, the mains input terminal shall be identified.

6.2.2 The terminations, in case of dc (supply), shall be identified by the following marking:

Positive termination	+
Negative termination	-

*Preferred numbers (*first revision*).

†Specification for three-pin plugs and socket outlines.

6.3 Flexible Cords

6.3.1 Core Colours — Where the filter unit is provided with a 3-core flexible cord, the colours of the cores to be connected to the earth, live and neutral terminals shall be green, red and black respectively.

6.3.2 Cord Anchorage — A filter unit with a non-detachable flexible cord shall be provided with a cord anchorage such that the ends of the conductors connected to the terminations are relieved from the strain including twisting. Compliance is checked by inspection and by the following test:

The filter unit is fitted with a flexible cord, the cord anchorage being used in the normal way. The conductors are introduced into the terminations and the screws, if any, are slightly tightened so that the conductors cannot easily change their position. After this preparation it shall not be possible to push the cord further into the filter unit. With the filter unit at operating temperature the flexible cord is then subjected 10 times for 1 second to a pull of 70N. The pull is not applied in jerks. Immediately afterwards, the cord is subjected for a period of 1 minute to a torque of 35 Nm applied at the most unfavourable position. The test is made with the flexible cord supplied with the appliance.

During the test damage shall not be caused to the flexible cord.

At the end of the test the cord shall not have been displaced by more than 2 mm and the end of the conductors shall not have been noticeably displaced in the terminals.

6.4 Safety Requirement — Filter units intended to be mounted separately, whether internally or externally to an electrical device, or in electrical wiring shall be constructed in accordance with the safety requirements.

6.5 Sealed and Unsealed Filter Units — Filter units shall be constructed using components complying with 5. The filter units may be unsealed (that is being an unprotected assembly or having a simple protective casing) or sealed.

NOTE — The test schedules for sealed and unsealed filters are different in some respects (see Table 3).

7. MARKING

7.1 Each filter unit shall be marked with the following information:

- a) Maker's name or trade-mark or type designation;
- b) Maker's catalogue or type number;
- c) The working voltage, dc or ac (rms) and the maximum current rating;
- d) A circuit diagram of internal wiring showing all capacitance values or the effective capacitance values regarding linkage current at 50 Hz between each pole of the supply and between each pole and earth.

NOTE 1 — If abbreviations are employed, the following letters shall be used:

- | | |
|---------------|----|
| i) Volts | V |
| ii) Amperes | A |
| iii) Watts | W |
| iv) Frequency | Hz |

NOTE 2 — The symbols for the nature of the supply shall be:

- | | |
|------------------------|---|
| i) Alternating current | ~ |
| ii) Direct current | — |

NOTE 3 — The filter unit shall be clearly marked with as many of these marks as possible in the order of preference given above.

7.2 All the information specified in 7.1 shall be marked on the packing of the filter units. Any additional marking on the filter unit or its packing or both shall be so applied as not to cause confusion.

7.2.1 The product may also be marked with Standard Mark.

7.3 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

8. TESTS

8.1 Classification of Tests

8.1.1 Type Tests

8.1.1.1 Type approval procedure — The procedure for type approval shall be in accordance with IS: 2612-1965*.

8.1.1.2 Number of samples — A sample shall be representative of the range of values of the type under consideration.

NOTE 1 — The number of items in the sample shall be agreed between the supplier and the purchaser or supervising inspectorate as appropriate.

NOTE 2 — Any item that has been subjected to the type tests or any part of them, shall not be used in equipment or returned to bulk supply.

NOTE 3 — Some or all of these tests may be required to be repeated from time to time on samples drawn from current production to confirm that the quality of the product is still to the requirements of the specification.

8.1.1.3 Schedule for type testing — All filter units, both sealed and unsealed, shall be subjected to the tests given in Table 3 in the order stated.

8.1.2 Acceptance Test — Under consideration.

8.1.3 Routine Test — Under consideration.

*Recommendation for type approval and sampling procedures for electronic components.

TABLE 3 TYPE TESTS

(Clause 8.1.1.3)

TEST (1)	CLAUSE REFERENCE	
	Sealed Filter Units (2)	Unsealed Filter Units (3)
Group 0 (all samples)		
Visual examination	8.4.1	8.4.1
Dimensions	8.4.2	8.4.2
Electrical continuity	8.3.1	8.3.1
Insulation resistance	8.3.2	8.3.2
Voltage proof	8.3.3	8.3.3
Insertion loss	8.3.4	8.3.4
Group 1		
Robustness of terminations	8.4.3	8.4.3
Soldering	8.4.4	8.4.4
Group 2		
Rapid change of temperature	8.7	—
Vibration	8.4.5	8.4.5
Bump	8.4.6	8.4.6
Group 3		
Climatic sequence	8.5	—
Group 4		
Damp heat (long term exposure)	8.6	—
Group 5		
Endurance	8.8	—
Group 6		
Short circuit	8.9	—

8.2 General Conditions for Tests

8.2.1 Unless otherwise specified below, all tests shall be carried out under general conditions for testing as specified in IS : 589-1961*.

8.2.2 Before the measurements are made, the items shall be stored at the measuring temperature for a time sufficient to allow the entire filter unit to reach this temperature.

8.2.3 When measurements are made at a temperature other than the reference temperature the results shall, when necessary, be corrected to

*Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

the reference temperature. The ambient temperature during the measurements shall be stated in the test report. During measurement the items shall not be exposed to draughts, direct sun-rays or other influences likely to cause error.

8.3 Electrical Tests

8.3.1 Electrical Continuity — Using a dc ohm-meter with an applied voltage of less than 10 V, the electrical continuity shall be checked between all pairs of terminals where the circuit diagram indicates there should be continuity. No open circuit shall be found.

NOTE — If required for comparison purposes, the dc resistance shall be recorded.

8.3.2 Insulation Resistance — The insulation resistance shall be measured across each pair of terminals specified in Table 4.

The test voltage shown in Table 4 shall be applied until a steady reading is obtained or for 60 s whichever is sooner. The value obtained shall not be less than 20 M Ω .

TABLE 4 INSULATION RESISTANCE TEST FOR FILTER UNITS

	RATED VOLTAGE		TEST VOLTAGE DC
	AC	DC	
—		Up to and including 100 V	10 \pm 1 V
Up to and including 100 V		100 V up to and including 500 V	100 \pm 15 V
Greater than 250 V rms		Greater than 500 V	500 \pm 50 V

8.3.3 Voltage Proof

8.3.3.1 Filter units shall withstand for 1 minute without any breakdown, a voltage applied according to Table 5.

TABLE 5 VOLTAGE PROOF TEST FOR FILTER UNITS

FILTERS FOR	PAIRS OF TERMINALS	TEST VOLTAGE
(1)	(2)	(3)
AC	Each line terminal and neutral terminal; Each pair of line terminals (3-phase filters only)	4.3 U_n dc
	Each line terminal and the earth terminal; Neutral terminal and the earth terminal	1 500 V ac or 2 250 V dc
DC	Each line terminal and the neutral terminal; Each pair of line terminals (3-phase filters only)	30 U_n dc
	Each line terminal and the earth terminal; Neutral terminal and the earth terminal	2 000 V dc

8.3.3.2 AC test voltages shall be applied at a frequency of 50 Hz.

8.3.3.3 The value of U_R chosen shall be that applicable to the appropriate pair of terminals under test.

8.3.3.4 If the case of the filter is non-metallic, or is metallic with an insulating sleeve, a metal foil shall be closely wrapped round the body of each filter so as to leave a space of at least 5 mm between the edge of the foil, and any terminal. A voltage of $2 U_R + 1\,500$ V rms at 50 Hz shall be applied for 1 minute between this foil and all terminals (including the earth terminal) connected together without any breakdown.

8.3.4 Insertion Loss — The asymmetric insertion loss without load current shall be determined at specified frequencies over the frequency range for which the filter is designed. The asymmetric insertion loss at simulated full load current of filter units which include inductors with ferro-magnetic cores shall be determined over such parts of this frequency range as agreed between the manufacturer and the user. The method of measurement shall be in accordance with IS : 8912-1978*.

NOTE — Insertion loss of the filter is usually measured without load current at two frequencies, one near the lower and the other near the upper end of the design frequency range.

8.3.4.1 For dc rated filters the simulated current shall be the rated current. For ac rated filters the simulated current shall be a direct current of 1.4 times the ac rating.

8.3.4.2 Specified test frequencies may be selected from the following preferred values:

0.16, 0.24, 0.55, 1.0, 1.4, 2.0, 3.5, 6.0, 13, 22, 45, 65, 90, 150, 180 and 220 MHz.

8.3.4.3 The insertion loss shall not be less than the value declared by the manufacturer.

NOTE 1 — Where specifically requested by the user these tests may be repeated at temperatures other than room temperature.

NOTE 2 — Measurement of symmetrical insertion loss is not mandatory, but a suggested method is described in IS : 8912-1978*.

8.4 Physical and Mechanical Tests

8.4.1 Visual Examination — The condition, workmanship, marking and finish shall be satisfactory.

8.4.2 Dimensions — The dimensions relating to interchangeability shall be checked against the appropriate drawings and shall be within the stated tolerances.

*Method of measurements of the suppression characteristics of electromagnetic interference filters.

8.4.3 Robustness of Terminations — This test shall be carried out in accordance with 7.19 of IS : 589-1961*.

8.4.3.1 Tensile test — The load to be applied shall be 20N for all types of terminations except wire terminations. For wire terminations see Table 6.

TABLE 6 TENSILE TEST FOR WIRE TERMINATIONS

CROSS-SECTIONAL AREA OF THE WIRE mm	CORRESPONDING DIAMETER OF ROUND WIRE mm	LOAD N
Up to and including 0.2	Up to and including 0.5	5
Exceeding 0.2 and up to and including 0.5	Exceeding 0.5 and up to and including 0.8	10
Exceeding 0.5	Exceeding 0.8	20

8.4.3.2 Bending test — Two consecutive bends shall be applied to two samples.

8.4.3.3 Torsion test — Two consecutive rotations shall be applied to the three remaining samples.

8.4.3.4 Torsion test on screw terminals (For use on nuts or threaded terminations only) — After each of the above tests the filter unit shall be visually examined. There shall be no visible damage.

8.4.4 Soldering — This test shall be carried out in accordance with 7.18 of IS : 589-1961*.

8.4.4.1 Solderability — Method 2 shall be applied to wire terminations in the 'as received' condition at a point 6.5 mm from the emergence of the wire from the termination. The soldering time shall be 3 s maximum. Other terminations shall be tested in the 'as received' condition using Method 1.

8.4.4.2 Intermediate measurements — The electrical continuity shall be measured as in 8.3.1. The dc resistance shall be recorded.

8.4.4.3 Resistance to soldering heat — This test shall be carried out in accordance with 7.18 of IS : 589-1961*.

8.4.4.4 Final measurements — There shall be no visible damage. The electrical continuity shall be measured as in 8.3.1. The dc resistance shall be within ± 20 percent or 20 M Ω , whichever is the greater, of the value recorded in 8.4.4.2.

8.4.5 Vibration — The test shall be carried out in accordance with IS : 2106 (Part XVI)-1971† within the frequency range 10-500 Hz with a

*Basic climatic and mechanical durability tests for components for electronic and electrical equipment (revised).

†Environmental tests for electronic and electrical equipment: Part XVI Vibration test.

severity of 0.75 mm displacement amplitude up to 57.5 Hz and 98 m/s² above that frequency for a duration of 6 hours by sweeping.

8.4.6 Bump — The test shall be carried out in accordance with Sec 2 of IS : 9000 (Part VII)-1979* with a severity of 390 m/s² for 4 000 bumps of 6 ms duration.

8.4.7 Final Measurements

- The filter shall be visually examined. There shall be no visible damage.
- The electrical continuity shall be measured as in 8.3.1. The dc resistance shall be within ± 20 percent or 20 M Ω whichever is the greater, of the value recorded in 8.3.4.1.
- The insertion loss shall be measured as in 8.3.4.

The values shall not have changed by more than the amounts shown in Table 7.

TABLE 7 PERMITTED CHANGES OF INSERTION LOSS

INITIAL VALUE dB	PERMITTED CHANGE dB
Up to and including 40	± 2
Over 40 up to and including 60	± 3
Over 60 up to and including 80	± 4
Over 80 up to and including 100	± 5
Over 100	shall not fall below 95

8.5 Climatic Sequence Tests

8.5.1 Initial Measurements — Measurements of electrical continuity and insertion loss shall be made in accordance with 8.4.7.

8.5.2 Dry Heat — The tests shall be carried out as per IS : 9000 (Part III)-1977† at upper category temperature.

8.5.3 Damp Heat (Cycling) — The test shall be carried out as per IS : 2106 (Part II)-1962‡ for one cycle. After recovery the item shall be subjected immediately to cold test.

NOTE — This test shall be omitted for -/-/04 components.

*Basic environmental testing procedures for electronic and electrical items: Part VII Impact test.

†Basic environmental testing procedures for electronic and electrical items: Part III Dry heat test.

‡Environmental tests for electronic and electrical equipment: Part II Damp heat (cycling) test.

8.5.4 Cold — The tests shall be carried out in accordance with IS : 9000 (Part II)-1977* at lower category temperature for 2 hours. The recovery period shall be between 4 and 6 hours.

8.5.5 Damp Heat (Cycling) (Remaining Cycles) — The test shall be carried out according to IS : 2106 (Part II)-1962†. This test is not applicable to -/-/04 day components. For -/-/21 day components, the test shall be applied for one cycle.

8.5.6 Final Measurements — The filter units shall be visually examined. There shall be no visual damage. The filter unit shall satisfy the requirements of **8.3.3** and **8.4.7**.

8.6 Damp Heat Test (Long Term Exposure)

8.6.1 Initial Measurements — Measurement of electrical continuity and insertion loss shall be made in accordance with **8.4.7**.

8.6.2 Damp Heat — The test shall be carried out in accordance with **7.3** of IS : 589-1961‡ with severity appropriate to the climatic category. There shall be no electrical loading during conditioning of the samples, standard recovery condition shall apply to surface moisture may be removed by blotting.

8.6.3 Final Measurements — The filter unit shall satisfy the requirements of **8.4.7**.

8.7 Rapid Change of Temperature Test

8.7.1 Initial Measurement — Measurement of electrical continuity and insertion loss shall be made in accordance with **8.3.1** and **8.3.4**.

8.7.2 Rapid Change of Temperature (Sealed Filters only) — The test shall be carried out according to IS : 2106 (Part VI)-1965§. The duration of exposure shall be 30 minutes at both upper and lower category temperature. The recovery time shall be between 1 and 2 hours.

8.7.3 Final Measurement — The filter shall satisfy the requirements of **8.4.7**.

8.8 Endurance Tests

8.8.1 Initial Measurements — Measurements of electrical continuity and insertion loss shall be made as in accordance with **8.3.1** and **8.3.4**.

8.8.2 Endurance — Filters for endurance tests shall then be divided into three sub-lots, for testing by the three methods below. Alternatively, the tests may be applied successively to the same lots of filters in the order stated.

*Basic environmental testing procedures for electronic and electrical items: Part II Cold test.

†Environmental tests for electronic and electrical equipment: Part II Damp heat (cycling) test.

‡Basic climatic and mechanical durability tests for components for electronic and electrical equipment (revised).

§Environmental tests for electronic and electrical equipment: Part VI Rapid change of temperature.

8.8.2.1 Current test — The filters shall be mounted in an air circulating oven where the air temperature is maintained at the filter rated temperature $\pm 3^{\circ}\text{C}$. 1.1 times the rated current shall be passed through the filter. The maximum case temperature of the filter shall be measured after thermal equilibrium has been reached and shall not exceed the upper category temperature. After 100 hours the filters shall be removed from the oven and allowed to cool to room temperature.

8.8.2.2 X-voltage test — The filters shall be mounted in an air circulated oven where the air temperature is maintained at the filter upper category temperature $\pm 3^{\circ}\text{C}$. The test voltage shall be as specified for the endurance test of X capacitors in Appendix A and shall be applied between the line terminal (s) and neutral for 1 000 hours 3-phase filters shall be tested by the application of a 3-phase supply.

8.8.2.3 Y-voltage test — The filters shall be mounted in an air circulating oven where the air temperature is maintained at the filter upper category temperature $\pm 3^{\circ}\text{C}$. The test voltage shall be as specified for the endurance test for Y capacitors in Appendix A and shall be applied between the line and neutral terminals connected together and the earth terminal for 1 000 hours.

8.8.3 The filter unit shall satisfy the requirements of **8.3.1**, **8.3.3** and **8.4.7**.

8.9 Short Circuit Test

8.9.1 Short Circuit — A test current shall be passed through the filter with load terminals connected together for 1 second. This current shall be either 50 times the rated current or that current resulting from the application of the rated voltage to the supply terminals of the filters with the load terminals of the filter short circuited, whichever is the less.

8.9.2 For single-phase filters containing two identical coils having a common magnetic core the test shall be carried out as follows:

- a) Between line supply terminal and line load terminal; and
- b) Between line and neutral supply terminals with line and neutral load terminals short-circuited together.

8.9.3 For 3-phase 3-wire filters containing three identical coils having a common magnetic core the test shall be carried out as follows:

- a) Between the *L1* supply terminal and the *L1* load terminals; and
- b) Between the *L1* and *L2* supply terminals with the *L1* and *L2* load terminals short-circuited together.

8.9.4 For 3-phase 4-wire filters consisting of three identical line coils and a neutral coil all having a common magnetic core the test shall be carried out as follows:

- a) Between the *L1* supply terminal and the *N*-load terminal;

- b) Between the N supply terminal and the N load terminal;
- c) Between the $L1$ and $L2$ supply terminals with the $L1$ and $L2$ load terminals short-circuited together; and
- d) Between the $L1$ and $L2$ supply terminals with the $L1$ and N -load terminals short-circuited together.

NOTE — Tests (b) and (d) above may be omitted if the line and neutral coils are identical.

During short circuit test the filter shall not explode or catch fire.

APPENDIX A

(Clauses 8.8.2.2 and 8.8.2.3)

ENDURANCE TEST

A-1. The capacitors in the filter shall be submitted to an endurance test of 1 000 hours at the voltage as specified below and at the relevant maximum temperature of the rated temperature range.

Class	Ratio of Applied Voltages to Rated Voltages for	
	ac capacitors	dc capacitors
X	1.5 U_R	1.5 U_R
Y	1.7 U_R	1.7 U_R

The test voltage shall be applied to the capacitors individually and shall be alternating at the rated frequency for ac capacitors and direct for dc capacitors.

For dc capacitors the voltage shall be applied through a resistor whose value is approximately 1 ohm per applied volt.

Sections of multiple-section capacitors shall be subject to this test simultaneously.

For feed-through capacitors the maximum rated current shall be carried by the feed-through conductor during this test.

A-2. The capacitor shall be considered to have failed when a short-circuit occurs in any section of the capacitor or between any section and the case; or between sections.

A-3. The capacitors shall be placed in the test chamber in such a manner that no capacitor is within 25 mm of any other capacitor. The capacitors shall not be heated by direct radiation and the circulation of the air in the chamber shall be adequate to prevent the temperature from departing by more than $\pm 3^{\circ}\text{C}$ from the specified temperature of the chamber, at any point where capacitors are placed.

It shall be assumed in this test that the temperature of the capacitors is the same as the nominal temperature of the chamber.

A-4. After the specified period the capacitors shall be allowed to cool to standard atmospheric conditions for testing.

A-5. The capacitors shall then be visually examined. There shall be no visible damage.

A-6. The capacitance shall be measured 24 ± 4 hours after the conclusion of the endurance test, unless it can be demonstrated that stability of capacitance is reached earlier.

The change of capacitance shall not exceed 10 percent.